

June 1996

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

These reports are now available via the World Wide Web at
<http://frf.wes.army.mil/frf.html>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and criticisms are welcome.

Introduction

1

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511 (c.baron@cerc.wes.army.mil).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

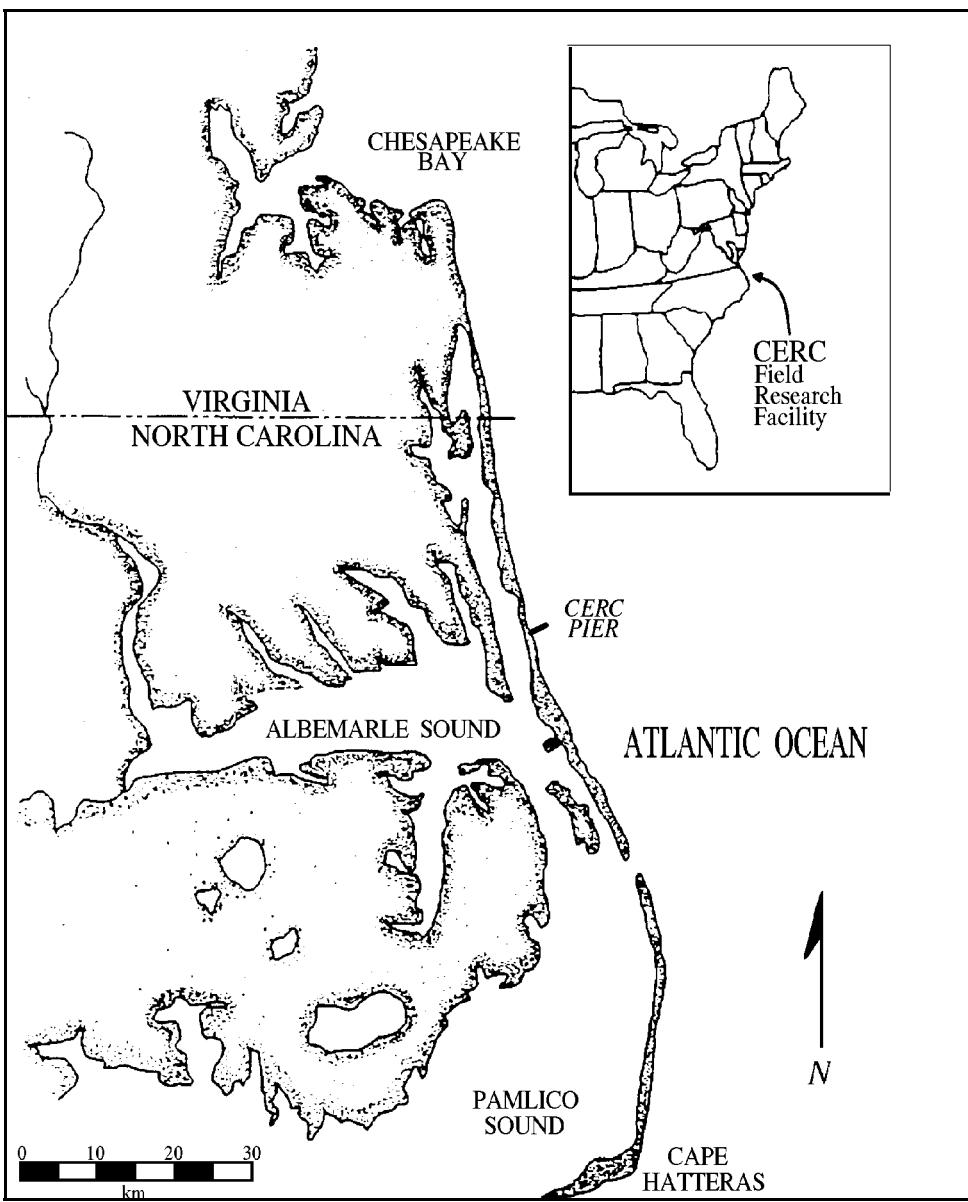


Figure 1. FRF Location Map

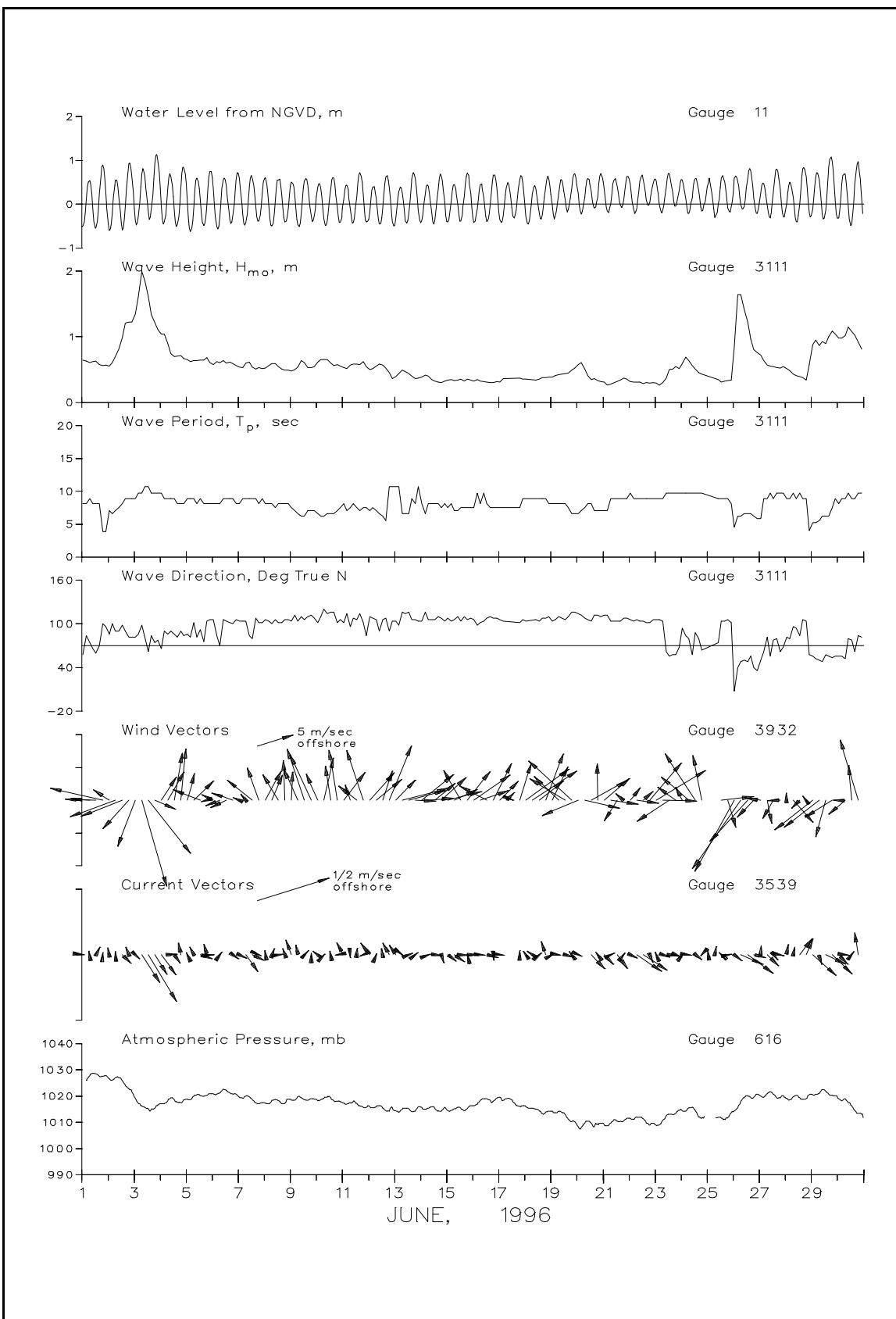


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		June 1996																														
		Day of the month																														
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	
616	Atmospheric Pressure	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
624	Air Temperature	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	- - -	- - -	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	- - -	
3932	Anemometer	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
641	Pressure Gauge on FRF pier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff on FRF pier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
		Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
3111	8 Meter Array 309 m north of FRF	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
111	Pressure Gauge center of 8 Meter Array	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	*	*	/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
		Data Collected	*	*	/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11	NOAA tide gauge at end of pier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																									
Data Collected		*	= All	/	= Partial	-	= None																									
Visual Observations		*	= Complete	/	= Partial	-	= None																									

Table 2
Gauge Locations

Gauge*	Description	* Latitude ID *	* Degrees N	* Longitude Degrees W	* FRF Coordinates CrossshoreT Longshore*	* Gauge Depth NGVD, m	* Water Depth NGVD, m
616	* Atmospheric Pressure*	36 10' 57.03"	*	75 45' 5.50"	*	11.60	*
3932	* Anemometer	*	36 11' 1.23"	*	75 44' 43.07"	585.20	*
641	* Pressure Gauge	*	36 10' 57.71"	*	75 44' 56.23"	239.11	*
625	* Baylor Staff	*	36 11' 1.04"	*	75 44' 43.72"	568.00	*
3111	* 8 Meter Array North	*	36 11' 19.14"	*	75 44' 36.41"	915.23	*
*	* 8 Meter Array South	*	36 11' 11.28"	*	75 44' 33.28"	914.20	*
*	* 8 Meter Array East	*	36 11' 13.70"	*	75 44' 32.56"	954.51	*
*	* 8 Meter Array West	*	36 11' 12.48"	*	75 44' 37.11"	834.66	*
111	* Pressure Gauge in center of 8 M Array	*	36 11' 14.06"	*	75 44' 34.39"	914.43	*
630	* Waverider Buoy	*	36 10' 5.10"	*	75 41' 59.30"	3934.96	*
3539	* Current Meter	*	36 11' 23.57"	*	75 44' 9.12"	1605.80	*
11	* NOAA Tide Gauge	*	36 11' 1.25"	*	75 44' 42.60"	596.49	*
R	R	R	R	R	R	R	R

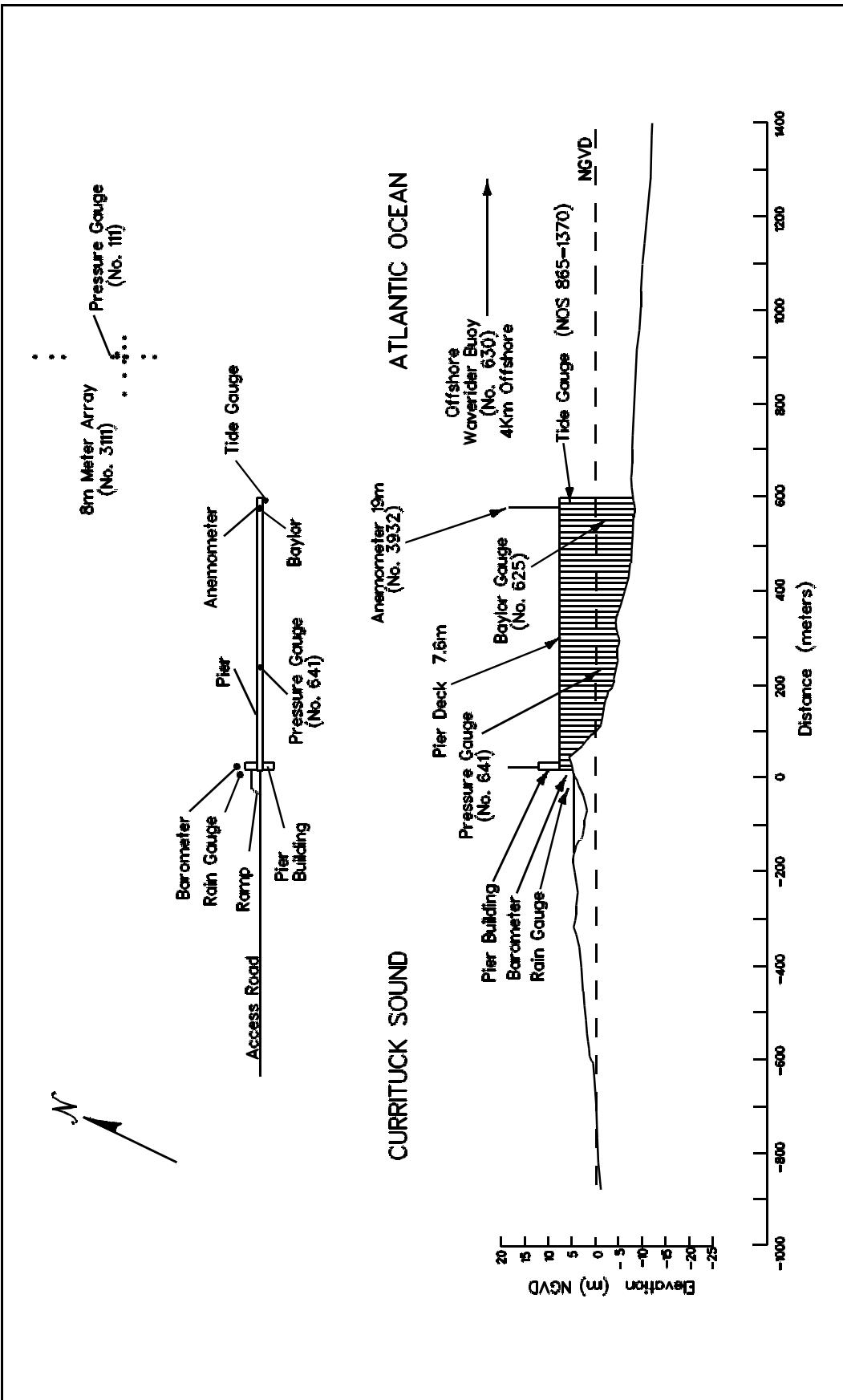


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

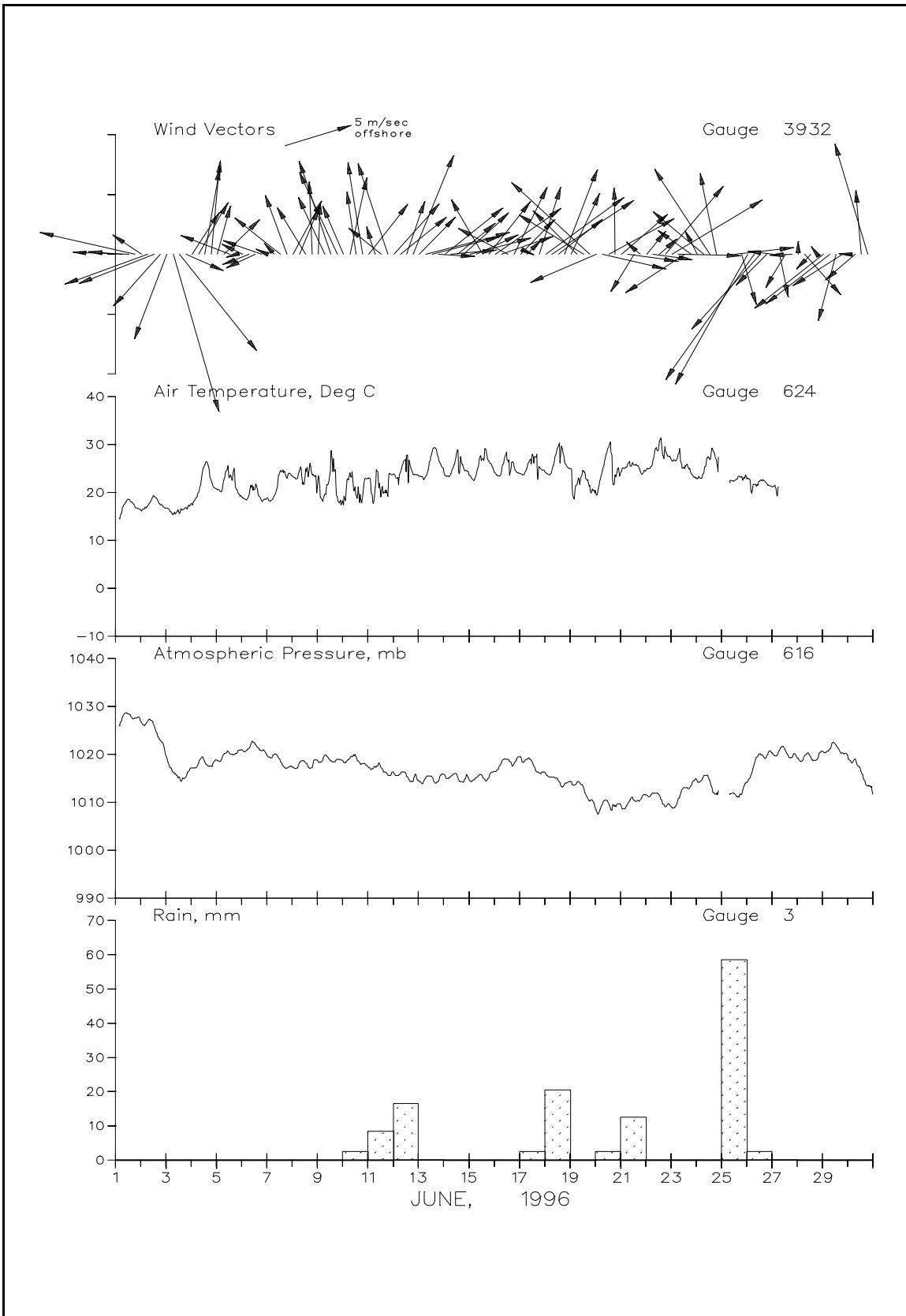


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jun 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	131	14.5	1026.8	0
	700	2	95	16.9	1027.8	0
	1300	4	92	18.5	1028.5	0
	1900	7	105	16.9	1027.7	0
2	100	3	127	16.1	1026.8	0
	700	6	67	17.1	1027.0	0
	1300	6	65	19.2	1025.9	0
	1900	5	38	17.4	1022.9	0
3	100	7	18	16.8	1019.3	0
	700	13	1	15.6	1016.4	0
	1300	10	325	15.6	1015.3	0
	1900	3	1	16.9	1015.4	0
4	100	4	209	17.5	1017.2	0
	700	5	206	20.0	1018.3	0
	1300	7	188	25.8	1018.6	0
	1900	8	184	22.4	1017.6	0
5	100	4	193	20.5	1018.8	0
	700	4	221	22.6	1020.0	0
	1300	4	114	23.3	1020.2	0
	1900	1	71	20.7	1020.3	0
6	100	2	119	18.8	1020.9	0
	700	2	65	19.4	1021.3	0
	1300	2	61	20.8	1022.1	0
	1900	3	112	18.3	1020.9	0
7	100	1	116	18.8	1019.6	0
	700	1	143	19.4	1020.0	0
	1300	4	132	24.7	1018.6	0
	1900	5	162	22.9	1017.2	0
8	100	5	204	23.3	1017.3	0
	700	4	199	24.6	1018.4	0
	1300	4	152	24.9	1018.3	0
	1900	6	178	23.7	1017.4	0
9	100	4	181	23.5	1018.5	0
	700	5	158	19.7	1019.9	0
	1300	8	163	28.6	1018.7	0
	1900	7	158	19.0	1019.0	0
10	100	4	159	17.4	1018.4	0
	700	6	190	24.1	1019.3	2
	1300	5	172	19.5	1019.5	0
	1900	8	172	19.2	1018.2	0

Table 3
Meteorological Data (continued)

Jun 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	5	213	23.1	1017.4	0
	700	2	164	21.1	1017.5	8
	1300	3	132	20.3	1017.2	0
	1900	8	164	19.1	1015.7	0
12	100	5	217	23.8	1016.1	0
	700	5	226	24.2	1016.0	17
	1300	5	196	27.8	1015.4	0
	1900	9	199	23.8	1014.4	0
13	100	4	219	23.4	1014.4	0
	700	6	253	23.3	1015.1	0
	1300	5	253	28.6	1015.2	0
	1900	3	273	27.3	1014.4	0
14	100	6	227	23.6	1015.7	0
	700	3	264	23.9	1015.5	0
	1300	4	226	29.0	1015.4	0
	1900	5	223	25.1	1014.3	0
15	100	5	252	23.5	1014.5	0
	700	3	241	23.7	1015.2	0
	1300	5	153	27.1	1015.4	0
	1900	5	214	26.5	1015.2	0
16	100	6	231	24.0	1016.5	0
	700	4	248	24.3	1018.4	0
	1300	4	121	26.8	1019.0	0
	1900	6	203	25.4	1018.2	0
17	100	4	219	23.9	1019.6	0
	700	2	220	25.0	1019.1	2
	1300	0		27.6	1017.9	0
	1900	6	195	25.3	1016.2	0
18	100	7	229	24.1	1016.0	0
	700	7	232	24.7	1015.3	20
	1300	4	227	29.6	1014.5	0
	1900	7	198	26.5	1013.8	0
19	100	5	202	25.0	1014.4	0
	700	5	138	21.7	1014.3	0
	1300	6	125	24.4	1013.0	0
	1900	8	136	21.4	1010.3	0
20	100	5	63	19.5	1008.3	0
	700	5	1	24.6	1009.7	3
	1300	6	237	29.4	1009.8	0
	1900	6	179	23.7	1009.4	0

Table 3
Meteorological Data (concluded)

Jun 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	5	224	24.4	1009.1	0
	700	4	279	25.9	1009.7	12
	1300	4	1	25.7	1010.4	0
	1900	1	134	24.4	1010.6	0
22	100	2	215	24.8	1011.5	0
	700	3	1	26.6	1011.9	0
	1300	2	224	30.7	1011.5	0
	1900	7	216	28.6	1009.1	0
23	100	8	235	26.5	1008.9	0
	700	4	271	27.9	1010.8	0
	1300	5	53	25.0	1013.1	0
	1900	3	130	23.9	1013.5	0
24	100	2	156	22.9	1014.5	0
	700	5	134	24.0	1015.7	0
	1300	8	150	26.8	1014.6	0
	1900	7	170	26.8	1011.7	0
25	100		Hardware Error			0
	700		Hardware Error			58
	1300	4	262	22.5	1011.7	0
	1900	4	345	23.4	1011.8	0
26	100	12	25	23.0	1014.5	0
	700	12	31	21.7	1018.1	2
	1300	8	38	22.6	1020.2	0
	1900	3	40	21.8	1019.7	0
27	100	2	98	21.2	1020.0	0
	700	4	1		1020.9	0
	1300	3	27		1020.8	0
	1900	2	87		1019.4	0
28	100	1	179		1019.2	0
	700	4	322		1019.9	0
	1300	2	40	inoperative	1019.5	0
	1900	1	147		1019.1	0
29	100	7	47		1020.6	0
	700	6	48		1021.2	0
	1300	6	13		1021.9	0
	1900	4	53		1020.3	0
30	100	1	92		1019.1	0
	700	3	44		1019.1	0
	1300	5	175		1016.3	0
	1900	10	165		1013.5	0
		Resultant		Mean	Mean	Total
		2	177	23.0	1017.0	124

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using a iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Jun 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.35	9.5	inoperative		0.65	8.2	58		
	0700	0.38	8.6			0.61	8.9	74	0.70	8.6
	1300	0.30	6.6			0.63	8.2	60	0.67	8.6
	1900	0.43	3.5			0.56	3.9	100	0.78	3.5
2	0100	0.34	3.8			0.55	7.1	86	0.76	7.4
	0700	0.50	6.5			0.69	7.1	90	0.85	7.0
	1300	0.64	7.6			0.99	8.2	98	1.08	8.3
	1900	0.82	8.9			1.22	8.9	82	1.43	8.9
3	0100	1.03	8.9			1.34	8.9	82	1.37	8.9
	0700	1.14	9.5			1.99	9.8	98		
	1300	0.92	10.7			1.62	10.8	62		
	1900	0.81	9.9			1.22	9.8	74		
4	0100	0.61	5.9			1.04	9.8	66		
	0700	0.53	8.9			0.89	8.9	86		
	1300	0.38	8.1			0.70	8.9	86		
	1900	0.46	8.1			0.71	8.2	90		
5	0100	0.35	8.6	inoperative		0.65	8.9	86	inoperative	
	0700	0.38	8.3			0.64	8.9	102		
	1300	0.34	8.6			0.65	8.9	92		
	1900	0.34	7.4			0.68	8.2	104		
6	0100	0.36	8.1			0.58	8.2	106		
	0700	0.33	8.6			0.60	8.2	70		
	1300	0.40	8.6			0.60	8.9	104		
	1900	0.38	8.6			0.59	8.9	100		
7	0100	0.35	8.9			0.54	8.2	104		
	0700	0.31	7.6			0.60	8.9	104		
	1300	0.36	8.3			0.54	8.9	80		
	1900	0.31	8.9			0.53	8.2	102		
8	0100	0.35	8.6			0.52	8.2	106		
	0700	0.33	5.2			0.59	8.2	100		
	1300	0.41	7.6			0.55	8.2	102		
	1900	0.33	6.0			0.49	8.2	106		
9	0100	0.33	5.9			0.48	7.6	104		
	0700	0.31	6.3			0.54	6.6	104		
	1300	0.48	5.7			0.61	6.2	106		
	1900	0.34	7.6			0.53	7.1	112		
10	0100	0.41	6.3	inoperative		0.61	6.6	102	inoperative	
	0700	0.43	6.6			0.66	6.2	120		
	1300	0.41	6.3			0.60	6.6	116		
	1900	0.41	6.5			0.58	7.1	102		

Table 4
Wave Data (continued)

Jun 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.35	6.1	inoperative		0.53	8.2	102	inoperative	
	0700	0.35	8.6			0.57	7.6	96		
	1300	0.37	7.8			0.59	7.6	106		
	1900	0.43	7.4			0.62	7.6	102		
12	0100	0.33	7.2			0.50	7.1	110		
	0700	0.34	6.8			0.55	7.1	106		
	1300	0.37	6.1			0.57	6.2	106		
	1900	0.33	6.6			0.45	10.8	90		
13	0100	0.23	11.2			0.40	10.8	104		
	0700	0.30	5.9			0.49	6.6	116		
	1300	0.28	7.0			0.44	6.6	116		
	1900	0.26	8.9			0.36	8.2	106		
14	0100	0.23	5.7			0.38	8.2	104		
	0700	0.29	6.1			0.40	8.2	106		
	1300	0.21	7.8			0.33	8.2	106		
	1900	0.22	8.1			0.30	7.6	108		
15	0100	0.19	6.0	inoperative		0.34	7.6	108	inoperative	
	0700	0.22	7.4			0.33	7.1	106		
	1300	0.23	6.1			0.35	7.6	104		
	1900	0.26	6.5			0.36	7.6	106		
16	0100	0.21	7.4			0.33	7.6	106		
	0700	0.25	4.6			0.33	8.2	102		
	1300	0.20	7.2			0.31	8.2	108		
	1900	0.25	7.8			0.30	7.6	108		
17	0100	0.20	7.4			0.31	7.6	106		
	0700	0.26	8.1							
	1300	0.23	8.1							
	1900	0.30	7.8	inoperative						
18	0100	0.26	8.1							
	0700	0.29	8.9							
	1300	0.27	9.5			0.35	8.9	104		
	1900	0.31	8.6			0.38	8.9	108		
19	0100	0.27	7.8			0.38	8.2	104		
	0700	0.36	7.2			0.43	8.2	110		
	1300	0.39	7.6			0.44	8.2	106		
	1900	0.46	7.0			0.49	6.6	116		
20	0100	0.58	6.3	inoperative		0.58	6.6	114	inoperative	
	0700	0.50	5.7			0.50	7.6	108		
	1300	0.29	5.3			0.35	8.2	104		
	1900	0.30	7.0			0.34	7.1	112		

Table 4
Wave Data (concluded)

Jun 1996										
Day	Hour	641		625		3111			630	
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec
21	0100	0.25	6.8	inoperative		0.31	7.1	112	inoperative	
	0700	0.21	7.2			0.28	8.9	104		
	1300	0.24	8.6			inoperative				
	1900	0.24	6.6			0.37	8.9	108		
	22	0100	0.26	6.3			0.31	9.8	106	
22	0700	0.21	9.5			0.31	8.9	106		
	1300	0.23	6.3			0.29	8.9	104		
	1900	0.22	6.0			0.29	8.9	102		
	23	0100	0.23	5.9			0.29	8.9	106	
23	0700	0.19	5.5			0.30	8.9	104		
	1300	0.37	9.9			0.50	9.8	56		
	1900	0.38	9.5			0.55	9.8	58		
	24	0100	0.35	9.5			0.59	9.8	94	
24	0700	0.38	5.3			0.64	9.8	80		
	1300	0.36	9.9			0.51	9.8	88		
	1900	0.23	9.5			0.43	9.8	64		
	25	0100	inoperative		inoperative		inoperative			inoperative
25	0700	0.24	4.3							
	1300	0.19	8.3			0.31	8.9	104		
	1900	0.18	9.9			0.33	8.9	106		
	26	0100	0.35	3.1			0.85	4.6	8	
26	0700	1.13	6.3			1.64	6.2	48		
	1300	1.12	6.6			1.22	6.6	48		
	1900	0.63	6.5			0.81	6.2	40		
	27	0100	0.52	5.3			0.72	5.9	50	
27	0700	0.37	5.4			0.57	8.9	82		
	1300	0.33	9.5			0.55	8.9	78		
	1900	0.28	8.9			0.52	9.8	62		
	28	0100	0.27	8.9			0.52	8.9	82	
28	0700	0.28	4.5			0.43	9.8	96		
	1300	0.23	8.3			0.39	9.8	84		
	1900	0.21	9.2			0.34	8.9	104		
	29	0100	0.61	4.9			0.88	5.3	56	
29	0700	0.62	5.5			0.87	5.6	50		
	1300	0.62	5.9			0.90	6.2	58		
	1900	0.69	7.8			1.09	7.6	54		
	30	0100	0.48	8.9	inoperative		0.98	8.2	56	inoperative
30	0700	0.55	9.2			1.02	8.9	52		
	1300	0.59	9.5			1.08	8.9	78		
	1900	0.54	9.5			0.92	9.8	84		
	Mean	0.38	7.4	0.00	0.0	0.60	8.1	92	0.96	7.6
Std dev		0.19	1.6	0.00	0.0	0.30	1.3	20	0.28	1.7

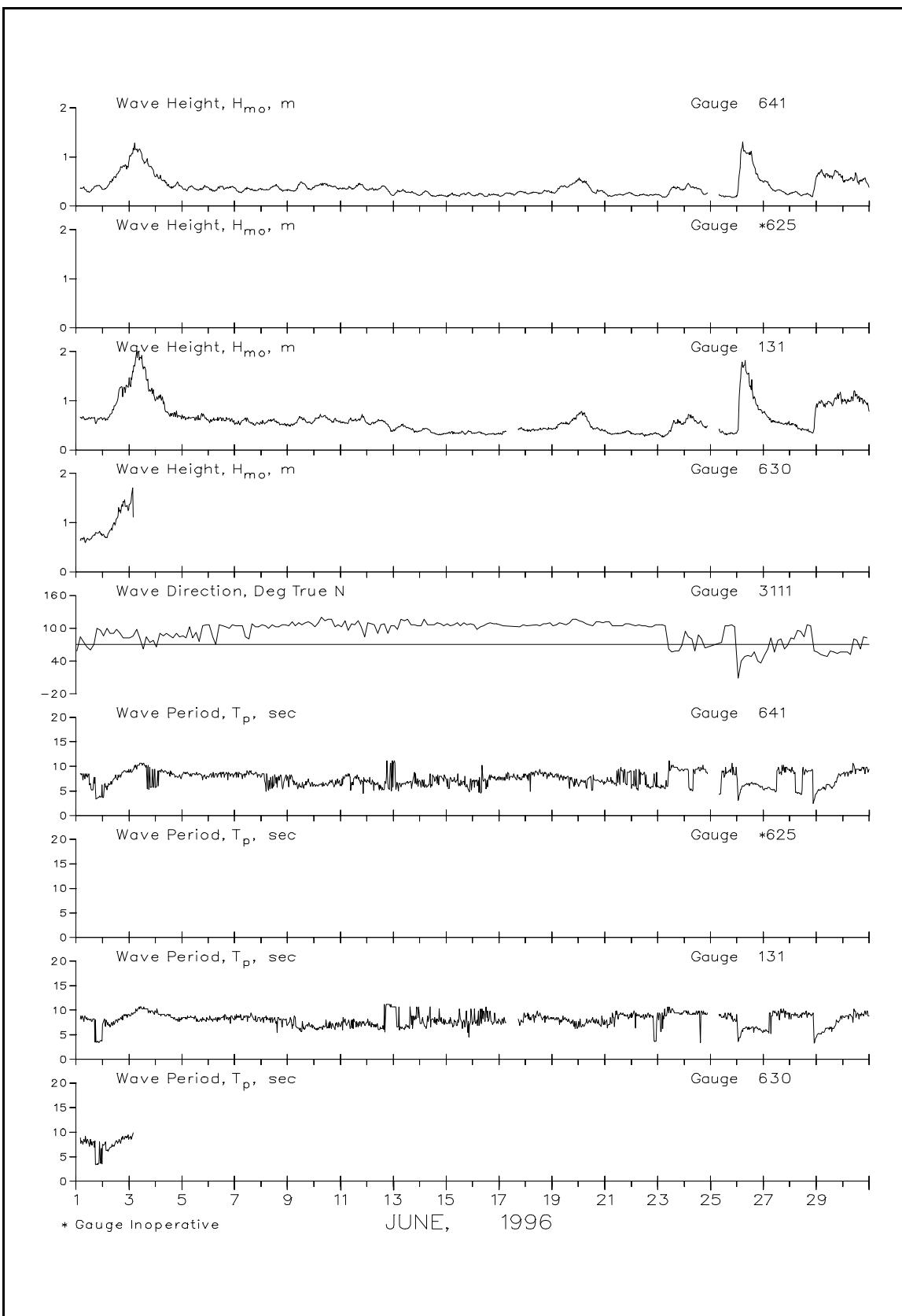


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

JUNE 1996																	
	Cross Long				Cross Long				Cross Long								
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	0	0	0		11	100	1	-9	10	333	21	100	-2	9	9	141
	700	0	-2	3	351		700	1	2	2	174		700	-2	0	3	62
	1300	-3	-4	6	24		1300	-1	-4	5	6		1300	-2	12	12	147
	1900	0	-1	2	4		1900	2	0	2	244		1900	0	0	0	
2	100	0	-4	5	350	12	100	3	-9	11	326	22	100	-3	4	5	118
	700	0	-1	2	358		700	0	0	0			700	-10	17	21	128
	1300	-2	8	9	138		1300	0	-4	5	351		1300	-10	16	20	127
	1900	0	-5	6	341		1900	1	-9	10	335		1900	0	6	6	161
3	100	-1	4	4	137	13	100	2	-7	8	328	23	100	0	-1	2	340
	700	-3	24	24	151		700	0	0	0			700	-3	3	5	114
	1300	-4	40	40	152		1300	-2	0	3	65		1300	-4	3	6	97
	1900	-2	17	17	151		1900	-1	0	2	48		1900	-2	3	4	116
4	100	-3	18	18	148	14	100	inoperative				24	100	0	0	0	
	700	-5	2	6	87		700	-1	0	2	66		700	0	1	2	98
	1300	0	8	8	150		1300	-3	2	5	100		1300	-2	5	6	133
	1900	-1	-8	9	351		1900	1	6	6	164		1900	1	1	1	217
5	100	0	-1	2	337	15	100	-2	7	8	133	25	100	0	-2	3	353
	700	1	-5	7	334		700	-3	7	8	129		700	-2	-5	6	8
	1300	-5	5	8	111		1300	-3	2	5	92		1300	1	-1	2	317
	1900	0	-7	8	347		1900	0	0	0			1900	-2	0	3	78
6	100	0	0	0		16	100	-2	1	3	88	26	100	-2	6	6	134
	700	-1	0	2	35		700	-2	1	3	95		700	-10	12	16	117
	1300	inoperative					1300	-5	4	7	107		1300	-10	19	22	130
	1900	-1	4	5	130		1900	1	4	4	176		1900	-5	5	8	106
7	100	-3	4	5	119	17	100	-1	1	3	101	27	100	-2	-5	7	4
	700	-2	15	15	148		700	inoperative					700	-3	10	11	137
	1300	-5	7	9	120		1300						1300	0	5	5	144
	1900	0	1	1	116		1900	0	-2	3	1		1900	-1	1	2	104
8	100	0	-2	3	352	18	100	1	-2	3	328	28	100	-3	-6	8	8
	700	-2	-3	5	18		700	3	-3	4	306		700	-2	-4	6	12
	1300	-2	1	3	81		1300	-1	0	2	46		1300	-11	-8	15	34
	1900	0	-4	5	341		1900	0	-9	10	345		1900	-7	-9	13	20
9	100	0	-11	12	341	19	100	-1	0	2	57	29	100	-8	20	22	136
	700	0	-6	8	347		700	0	1	2	101		700	1	7	8	167
	1300	-2	-1	4	40		1300	-4	4	6	108		1300	-9	11	15	118
	1900	0	0	0			1900	1	-2	3	326		1900	-6	18	19	138
10	100	2	-2	4	309	20	100	-1	2	3	120	30	100	-2	9	9	140
	700	0	0	0			700	inoperative					700	-1	1	2	99
	1300	0	-2	3	350		1300	-4	13	14	140		1300	-1	-1	3	35
	1900	1	0	1	258		1900	1	-1	2	326		1900	-3	-16	17	352

KEY:

+cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Jun 1996												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	-3	-18	19	331	-4	-15	16	326	South	27	N	
2	-6	-28	28	329	-9	-23	25	318	South	58	N	
3	0	51	51	160	-6	28	28	171	North	29	N	
4	-1	-5	5	331	6	-28	28	351	South	21	N	
5	4	-27	27	349	2	-20	20	346	South	12	N	
6	-6	-3	6	281	0	-23	23	340	South	30	N	
7	-3	22	22	169	2	-17	18	346	South	0		
8	3	-22	22	349	9	-44	44	351	South	29	N	
9	1	-27	27	343	0	-38	38	340	South	18	N	
10	2	-16	16	349	0	-41	41	340	South	34	N	
11	0	-29	29	340	3	-32	32	346	South	43	S	
12	7	-10	12	17	2	-19	19	346	South	30	N	
13	17	17	25	70	0	-5	5	343	South	26	S	
14	6	6	9	115	0	0	0		North	5	S	
15	10	6	11	99	4	6	7	70	North	11	S	
16	3	27	27	154	4	36	36	154	North	2	S	
17	0	-27	27	340	0	-17	17	340	South	6	N	
18	6	-23	23	354	4	-24	25	349	South	24	N	
19	6	-12	13	7	15	-24	28	11	South	34	N	
20	10	68	68	151	10	-38	39	354	North	29	N	
21	7	14	16	133	8	17	19	70	North	3	S	
22	4	76	76	157	7	17	19	138	North	23	S	
23	-5	36	36	169	0	25	25	160	North	15	N	
24	-6	-30	31	329	-7	-23	24	323	South	26	N	
25	6	-13	15	7	9	-22	23	2	South	21	S	
26	-15	51	53	177	5	102	102	157	North	59	N	
27	-9	61	62	169	-5	15	16	177	North	9	S	
28	3	23	23	151	-5	12	13	182	North	7	S	
29	-19	47	51	182	8	34	35	146	North	4	S	
30	-10	-19	21	313	-7	-29	30	326	South	6	N	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

				Jun 1996			
Day	Time	Wave Approach Angle at Pier End deg from True N		Water Characteristics at Pier End			
		Primary	Secondary	Width of Surf Zone,m	Temp.,C	Density g/cc	Secchi Vis.,m
1	0855	70		21	17.5	1.0181	2.1
2	0535	100	70	34	17.5	1.0200	2.1
3	0620	85	20	224	18.1	1.0210	1.5
4	0600	85		184	18.3	1.0187	1.8
5	0545	110		27	17.8	1.0210	1.5
6	0600	105		20	18.3	1.0217	2.1
7	0625	100		15	20.8	1.0170	1.8
8	0710	95		20	18.9	1.0216	2.7
9	0745	100		20	16.9	1.0238	2.4
10	0630	100		20	15.6	1.0242	3.0
11	0605	90		11	15.0	1.0243	3.0
12	0600	100		14	12.5	1.0246	3.0
13	0610	105		18	12.2	1.0250	3.7
14	0630	100		8	13.1	1.0248	3.4
15	0640	100	130	11	20.3	1.0214	2.7
16	0720	140		15	20.8	1.0211	2.7
17	0605	120		11	18.6	1.0226	2.7
18	0615	135		12	14.4	1.0243	3.0
19	0620	105		15	15.6	1.0242	3.0
20	0630	95	80	17	20.0	1.0216	2.4
21	0600	120		12	19.4	1.0232	3.0
22	0820	155		8	23.6	1.0194	3.7
23	0850	105		11	21.7	1.0213	3.7
24	0610	60		113	24.2	1.0188	3.0
25	0610	120		24	18.3	1.0228	2.4
26	0615	45		195	20.8	1.0220	3.0
27	0704	40	80	30	23.3	1.0166	1.8
28	0720	80		24	23.9	1.0162	1.2
29	1030	55		104	25.6	1.0146	1.5
30	1015	80	50	126	24.4	1.0150	1.2

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

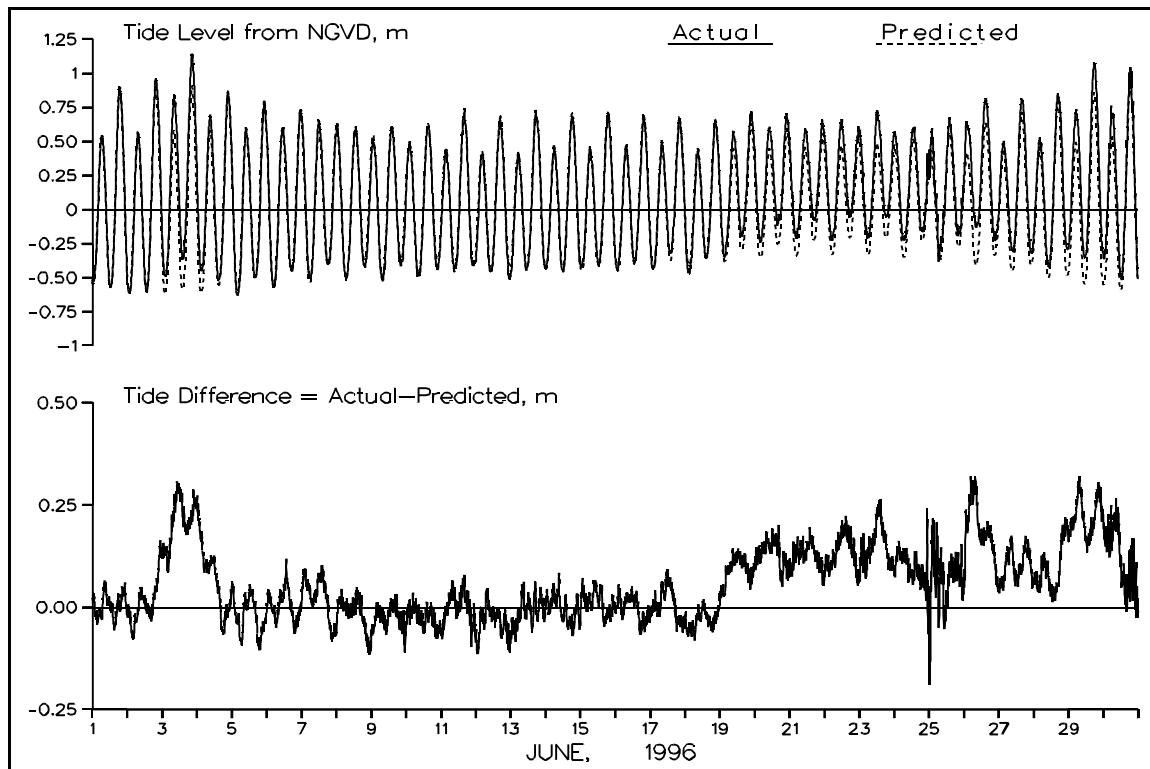


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

JUN 1996 Tide Levels																	
Day	High			Low			Mean	Range	High			Low			Mean	Range	
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day			
1	0700	0.54	1	0018	-0.53		0.08	1.07	16	0742	0.47	16	0112	-0.44	0.02	0.92	
1	1830	0.90	1	1230	-0.58		0.16	1.48	16	1930	0.69	16	1300	-0.40	0.14	1.09	
2	0712	0.56	2	0130	-0.62		-0.02	1.18	17	0754	0.51	17	0212	-0.44	0.03	0.95	
2	1930	0.97	2	1324	-0.61		0.19	1.57	17	2018	0.67	17	1412	-0.32	0.16	0.99	
3	0830	0.85	3	0206	-0.49		0.18	1.34	18	0912	0.44	18	0242	-0.47	-0.01	0.91	
3	2024	1.14	3	1418	-0.36		0.39	1.51	18	2042	0.65	18	1448	-0.36	0.14	1.01	
4	0900	0.70	4	0306	-0.45		0.13	1.15	19	0906	0.58	19	0312	-0.35	0.13	0.93	
4	2106	0.86	4	1500	-0.52		0.16	1.38	19	2154	0.72	19	1506	-0.20	0.26	0.92	
5	0930	0.61	5	0354	-0.63		0.00	1.24	20	1012	0.61	20	0406	-0.24	0.20	0.85	
5	2212	0.78	5	1548	-0.50		0.12	1.27	20	2148	0.71	20	1536	-0.12	0.28	0.83	
6	1112	0.61	6	0442	-0.58		0.04	1.19	21	1048	0.60	21	0430	-0.21	0.20	0.81	
6	2318	0.74	6	1724	-0.46		0.14	1.19	21	2218	0.66	21	1706	-0.08	0.27	0.74	
7	1136	0.66	7	0542	-0.50		0.08	1.16	22	1142	0.67	22	0454	-0.23	0.22	0.90	
8	0042	0.63	7	1806	-0.40		0.10	1.03	22	2324	0.61	22	1724	-0.06	0.28	0.67	
8	1318	0.61	8	0624	-0.52		0.06	1.13	23	1206	0.73	23	0518	-0.22	0.26	0.95	
9	0100	0.51	8	1942	-0.42		0.05	0.93	24	0018	0.58	23	1830	-0.06	0.26	0.64	
9	1412	0.61	9	0748	-0.52		0.06	1.13	24	1406	0.61	24	0654	-0.23	0.20	0.84	
10	0218	0.50	9	2018	-0.41		0.05	0.92	25	0200	0.60	24	1954	-0.17	0.19	0.76	
10	1536	0.61	10	0800	-0.49		0.07	1.10	25	1412	0.68	25	0642	-0.38	0.18	1.06	
11	0330	0.44	10	2142	-0.44		0.02	0.89	26	0200	0.65	25	1954	-0.19	0.23	0.84	
11	1606	0.75	11	0912	-0.43		0.13	1.18	26	1506	0.82	26	0824	-0.13	0.33	0.95	
12	0406	0.41	11	2230	-0.41		-0.01	0.82	27	0318	0.50	26	2112	-0.23	0.14	0.73	
12	1654	0.67	12	0954	-0.46		0.10	1.13	27	1548	0.81	27	1000	-0.31	0.24	1.13	
13	0454	0.41	12	2306	-0.51		-0.03	0.92	28	0418	0.53	27	2224	-0.32	0.11	0.85	
13	1706	0.73	13	1036	-0.45		0.14	1.18	28	1636	0.85	28	1036	-0.43	0.22	1.28	
14	0542	0.47	14	0012	-0.43		0.02	0.90	29	0512	0.73	28	2330	-0.29	0.23	1.02	
14	1800	0.69	14	1148	-0.46		0.12	1.15	29	1742	1.08	29	1130	-0.35	0.37	1.43	
15	0636	0.46	15	0048	-0.42		0.02	0.89	30	0524	0.76	30	0042	-0.36	0.20	1.13	
15	1900	0.71	15	1236	-0.41		0.15	1.13	30	1848	1.05	30	1230	-0.51	0.25	1.56	

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using either a Trimble 4000 GPS or a Geodimeter 140-T self-tracking total station for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in May 1996 and the survey(s) in June 1996 on profile line 188, located 517 m south of the pier.

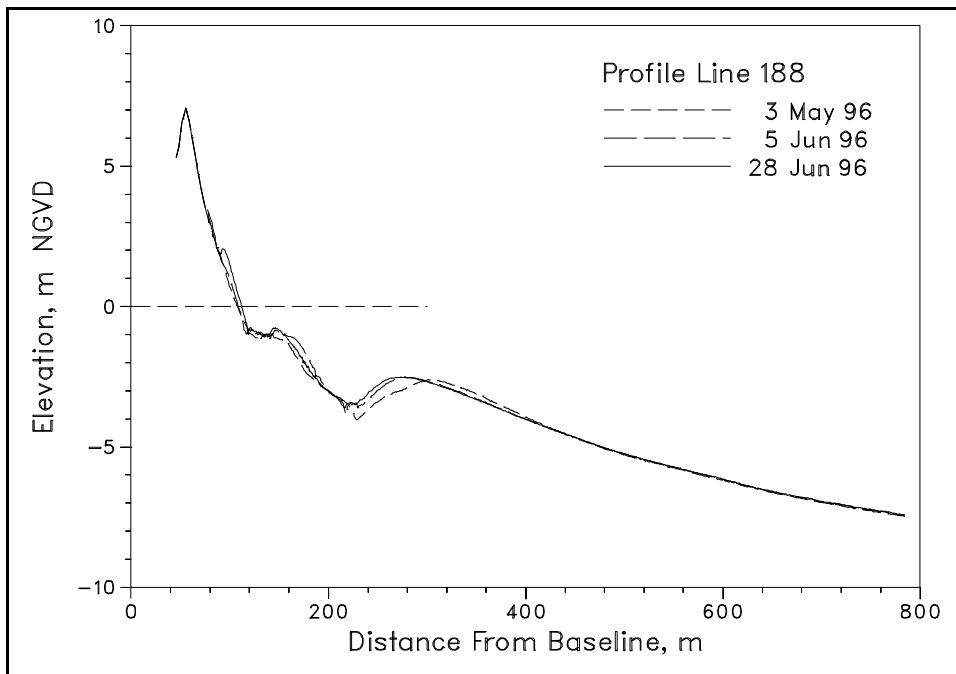


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1996. Cross-hatched areas indicate changes to the annual envelope which occurred in June.

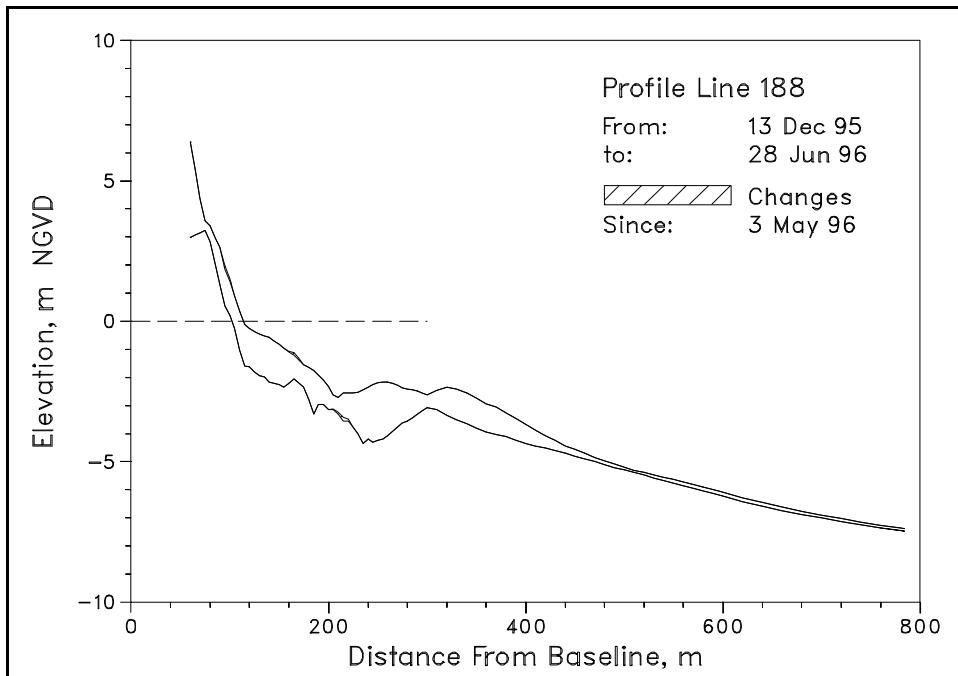
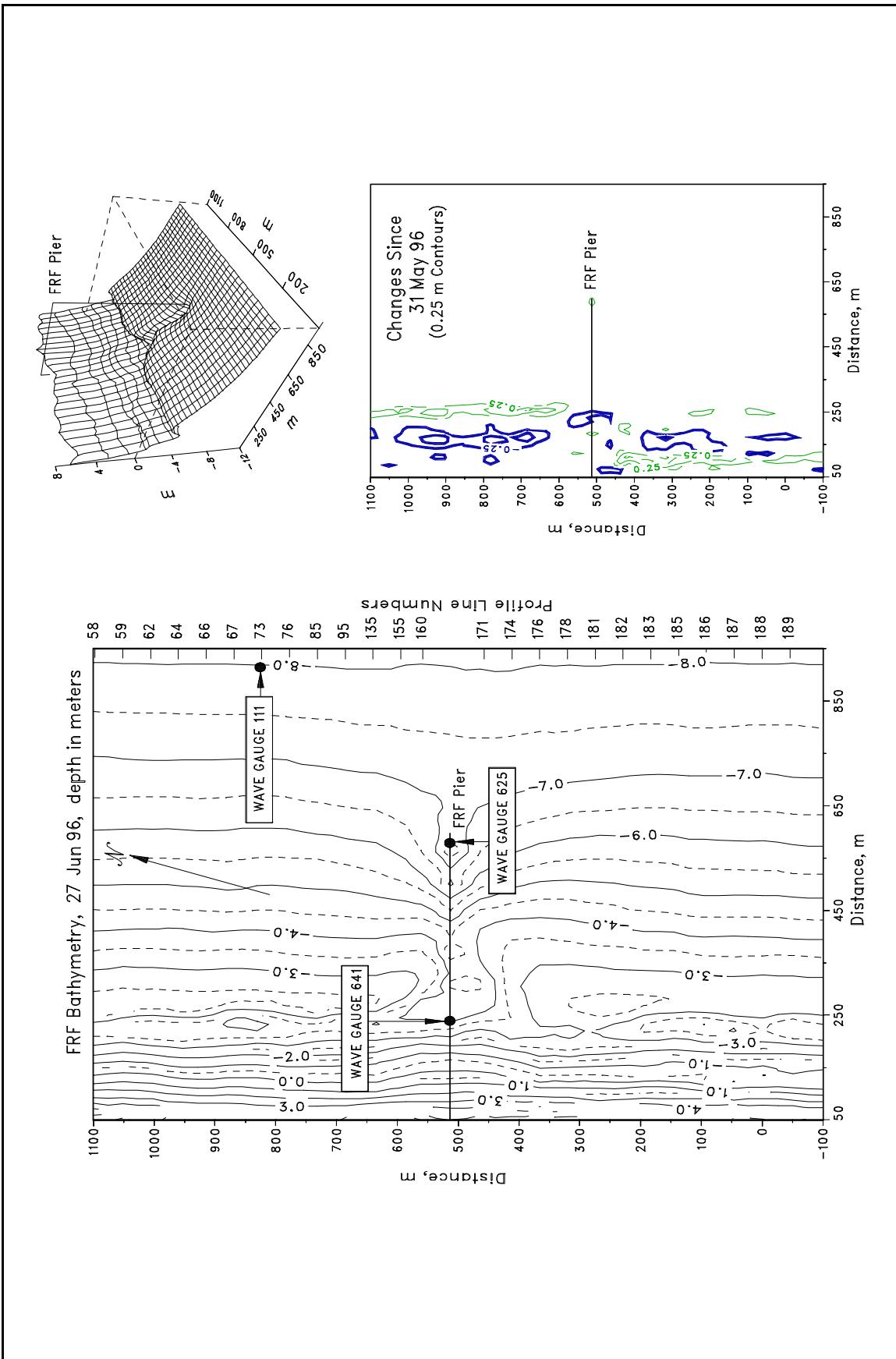


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 27 June. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

	<u>Start</u>	<u>End</u>
** Dec (0000)	** Dec (0000)	

B. Storm Synopsis.

Northeasterly winds were funneled between a Canadian high pressure system and a low pressure system over Cape Hatteras. Winds intensified as the low pressure system moved along the North Carolina coast and began moving out to sea by the morning of ** June. Maximum onshore winds (NE) reached ** m/s at 0000 EST on ** June. The minimum atmospheric pressure was *** mb. The maximum H_{mo} , at gauge 630, reached *.* m ($T_p=**.*$ s) at 0000 EST on ** June. There was * mm of precipitation.